Flora W. Patterson

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# MICHIGAN STATE AGRICULTURAL COLLEGE EXPERIMENT STATION

DEPARTMENT OF BACTERIOLOGY AND HYGIENE

## SOME BACTERIAL DISEASES OF PLANTS PREVALENT IN MICHIGAN.

[Popular.]

BY

WALTER G. SACKETT

AGRICULTURAL COLLEGE, MICHIGAN
1905

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## SUB-STATIONS

Grayling, Crawford County, 80 acres deeded.
South Haven, Van Buren County, 10 acres rented; 5 acres deeded.
Chatham, Alger County, 160 acres deeded.

# SOME BACTERIAL DISEASES OF PLANTS PREVALENT IN MICHIGAN.

I. Pear Blight.
II. Bacteriosis of Beans.
III. Black Rot of Cabbage.
IV. Wilt of the Cucumber, Muskmelon and Squash.
V. Soft Rot of the Sugar Beet.
VI. Blight of the Irish Potato, Tomato and Egg Plant.

WALTER G. SACKETT.

## PEAR BLIGHT (Fire Blight).

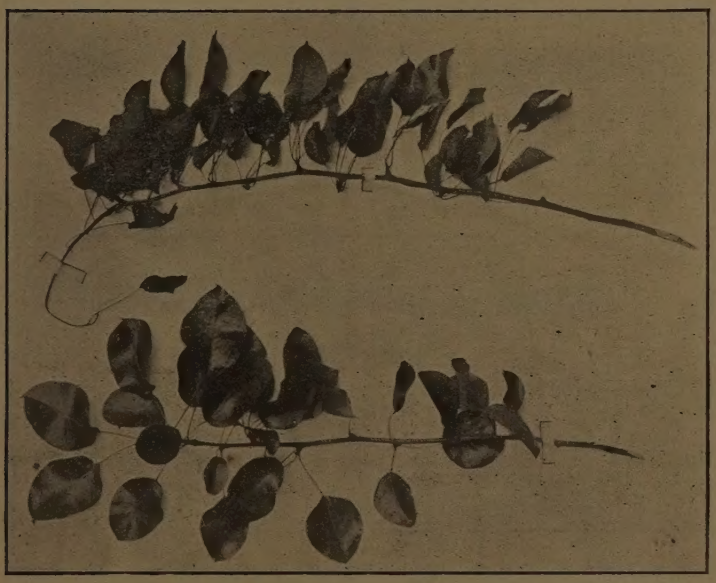

Fig. 1.—Two Pear Twigs; the upper one affected with Fire Blight, the lower one healthy.

Of all the diseases which affect the pear, there is none which is so universally dreaded by the fruit grower as the pear blight. This disease is by no means confined to the pear alone but also infests the apple, quince, crab, mountain ash, service berry and several species of hawthorne; hence the blight can spread from one kind of a tree to another.

The name *fire blight* is especially good because it is at once suggestive of the symptoms of the malady. To one not familiar with the disease, it can be recognized at first sight by the brown and subsequent blackened

appearance of the young leaf tufts and flower clusters; the young twigs show a blackened, shrivelled bark resembling very much green brush which has been only partially burned. The blight makes its appearance early in the spring shortly after the blossoms have fallen and working rapidly back from the blossom clusters, an inch or more a day, soon involves the tender succulent twigs and ultimately the whole limb. If the diseased wood be cut off with a sharp knife, a dark ring between the bark and the wood will usually be seen. This is a further indication that your tree is affected. As the disease progresses and the smaller limbs show the infection, the bark cracks and a thick, black, sticky gum exudes; soon afterwards the bark becomes dark colored, hardened and shrunken. When the leaves fall in the autumn, the diseased parts of the tree are left very conspicuous by the dead leaves hanging to the twigs. If the blight attacks the larger branches and trunk where there

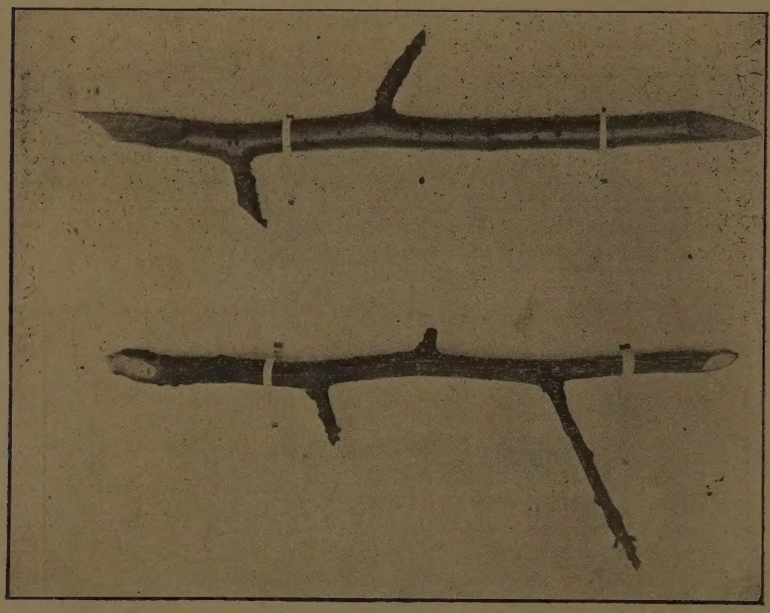

FIG. 2.—Pear Twigs. The upper one shows the smooth bark of a healthy twig. In the lower one note the dried up, shrivelled appearance caused by the Blight.

has been some mechanical injury or bruise, the symptoms are much the same as what is known as sun burn or sun scald. This form of the blight is known as rough bark or body blight.

In some of the most susceptible varieties, it is not uncommon to see the whole tree blighted in a phenomenally short time, sometimes within ten days. Occasionally it assumes its most severe form just previous to the picking of the crop. The writer has one pear orchard in mind numbering some four hundred trees which showed but three or four badly infected ones up to the middle of August, 1904, but within three

weeks after that, every tree in the orchard was suffering from a severe attack. The fruit had to be picked two weeks before time in order to prevent all from being ruined by the blight.

### HISTORY.

The disease is by no means recent for it dates back to the time of William Denning who first reported the trouble from the Highlands of the Hudson in 1770. He described it fairly well and ascribed the cause to a borer in the trunk of the tree.

The oldest book on American Fruit Culture published in 1817 by William Coxe gives a very accurate description of the disease. From this early date up to comparatively recent times horticultural literature has been crowded with numerous extravagant theories of the cause of the blight. Even today we occasionally find men who hold to one or another of the old ideas. It may be interesting to know what some of these were:

1. Insects.*
2. Rays of the sun passing through vapors.
3. Poor soil.
4. Violent changes in the temperature of the air or the moisture of the soil.
5. Sudden change from sod to high tillage resulting in surplus of sap.
6. Effect of age.
7. Autumn freezing of unripe wood, which makes a poison destroying the shoots and branches the following spring.
8. Electricity in the atmosphere.
9. Freezing of the sap or freezing of the bark.
10. Fermentation of sap.
11. Absence of certain mineral matters in the soil.
12. Something in the air which is carried from place to place.
13. Fungi.

### ORIGIN AND SPREAD.

In 1878, Prof. W. T. Burril of the University of Illinois, succeeded in finding a kind of bacteria which he believed to be responsible for the disease.

The blackened twigs and sticky exudate were found to be alive with germs which are very small plants, so small, in fact, as to be seen only with a very powerful magnifying glass such as we find in the compound microscope. Some idea of the size can be gotten when you know that it would require 25,000 germs placed end to end to make one inch.

By taking some of this gummy material which contains the bacteria and inserting it into a healthy twig through a small cut, it was demonstrated that the inoculated twig took the disease and that therefore it could be spread from one tree to another or was what we call an infectious disease. It was also shown that this same gummy material from the pear could produce the disease on the quince and the apple. This experiment is very simple and can be tried by anyone who is interested in the infectious nature of the blight. It was argued by some that it was not the germs which produced the blight but rather the gum which was injected. To meet this objection, the germs were grown in a suitable medium such as beef broth and a quantity of the pure organ-

* Bulletin 136 Ontario Department of Agriculture.

isms were inoculated into a healthy twig. The results were very conclusive for the twig soon died showing that the germs by themselves had the power of killing the plant.

The question which we now have to answer is, where does the blight originate when our orchards have never had it before? Where does it come from? It has been shown quite conclusively that it is not carried on the wind, neither is it traceable to the soil. Insects and especially bees have been seen feeding on the gummy material which runs out from the cracks in the diseased wood and knowing that this exudate contains millions of germs, it is only reasonable to believe that these insects carry the disease on their feet and bodies to the healthy trees. Alighting on a delicate flower cluster, they crawl deep down after the so called honey or nectar in the blossom and here many of the blight germs are brushed off and left in contact with the tender blossom. Through these honey ducts or nectaries the bacteria gain entrance to the plant. Once favorably situated, they multiply very rapidly and move down the twig between the bark and woody cylinder through the growing layer, known as the cambium layer, which is familiar to everyone as the region from which the annual rings arise. It is in this way that a large percentage of the cases originate. Again the germs may gain entrance into the tender shoots through insect bites in the bark for although the opening may be no larger than a pin prick, myriads of bacteria can find a temporary dwelling place in this wound and may soon spread through the whole member. Lastly, the infection may enter the large limbs and trunk of the tree by some scratch or bruise in the protecting bark which has exposed the susceptible growing layer beneath to the visits of germ laden insects.

Thus we see that pear blight is caused by a germ to which the name *Bacillus amylovorus* (Burril) has beeen given, the meaning of which is starch destroying. We see that it is spread from one tree to another by insects, especially bees, and that the germs may gain entrance into the plant in any of three ways: First, and most important, through the blossom; second, through insect bites in the tender shoots; third, through mechanical injuries to the bark of the limbs and trunks of the trees.

### CONDITIONS FAVORING THE DISEASE.

Although the knife is our only hope of exterminating the blight, there are undoubtedly conditions which favor the disease.

It is a matter of common observation that climatic conditions have a marked influence; warm, moist weather with a large amount of rainfall favors it, while bright, dry, cool weather tends to check it. That is, the former conditions are advantageous to the growth of the germs while the latter are unfavorable.

High cultivation, rich soil, heavy manuring, the use of large quantities of commercial fertilizer containing a great deal of nitrogenous material and heavy pruning all tend toward the growth of tender, succulent shoots. It is in this sort of plant tissue, gorged with sap, that the blight germs can grow and multiply most rapidly. Biting insects whose mouth parts are contaminated with the casual microbes, are most partial to these juicy shoots and leaves and their bites often serve to infect the tree.

It is evident, then, that vigorous, healthy, rapidly growing, too well cared for orchards are more liable to the disease than others and since these are factors which the grower can control, it is he who must strike the happy medium which will not permit the trees to suffer and yet will not give ideal conditions for the development of the germs.

### PREVENTION AND TREATMENT.

The treatment of fire blight is of two kinds—the one, preventative, which aims at making the tree resistant to the attacks of the disease; the other, curative, which is intended to exterminate the harmful microbes and thus prevent their spread.

(1) It is obvious that if we are to render our trees resistant to blight, we must avoid those conditions which increase the predisposition to the disease. We have already mentioned the most potent factors in the propagation of blight as high cultivation, rich manures, commercial fertilizer high in nitrogenous material, excessive soil moisture and high pruning. In short, anything which favors the rapid growth of tender, succulent shoots should not be practiced. It is understood, of course, that these suggestions are not to be followed without reason or the trees will suffer from troubles other than the blight. The trees should be allowed to ripen their wood and to this end the grower must use some means which will limit the moisture in the soil. It is recommended that some good cover crop such as oats be used for this purpose.

(2) With a disease working as this does in the juicy part of the stem between the bark and the wood, there is no chance of reaching the trouble by means of sprays for unless the chemicals come in contact with the bacteria, spraying is futile.

The knife and saw remain as the only effective remedies. We must cut out and burn all affected twigs, leaves and branches not only from the pear but the apple, quince and related species as well, so that there will be no infectious material near by for bees to carry into the blight free orchard. It is very essential in cutting out the diseased branches to cut well below the discolored part as the bacteria are usually far below this region, the discoloration not appearing until after the bacteria have been at work some time, so that even if all the blackened wood were removed the seat of the trouble would not have been reached, and the germs would live on in the apparently healthy stump, soon to cause another visible outbreak of the blight. The affected branches should be cut back all the way from ten to fifteen inches below the discolored wood and if the branch be a large one, more than one-half inch in diameter, the cut surface should be protected from wound rots by painting. Either lead and oil paint or shellac wash* or grafting wax may be used for this but the lead and oil paint is cheaper and less liable to crack than the others when exposed to the sun. The question may be asked, "When is the proper time to do the cutting?" The writer would answer, "Whenever the blight appears." Trimming out the diseased parts may be done at any time in the late fall, winter and spring. The most favorable time, however, is in the autumn after the leaves have fallen for then the blighted twigs become very conspicuous by the dead leaves still hanging to them. It is not advisable to postpone the cutting until

* The Connecticut Exp. Sta. recommends oil shellac to which is added a little flowers of sulphur and a few drops of carbolic acid.

the growing season, for at that time there is great danger of overlooking new cases which are constantly occurring owing to the lack of development so early in the season. If the entire tree is affected, there is little hope of saving it and the best procedure is to grub it out and burn the whole tree. Too much stress cannot be laid upon the complete destruction of the diseased wood for our only hope of stamping out the blight lies in removing the source of the infection. A single twig left on the ground unburned may mean the loss of the whole orchard.

The knife and the saw used must be sterilized after each cut in order that the disease germs clinging to the instruments may not be carried to the healthy parts of the tree. This can be done by passing the knife several times through a flame or it may be dipped into a 5 per cent solution of carbolic acid.

A careful inspection of the orchard should be made in the winter and spring before the blossom season in order to destroy any new cases that may have developed since the previous examination.

The greater part of the blight will be eradicated by one careful winter and spring cutting and if this be done and done thoroughly, the disease can be entirely controlled.

### SUSCEPTIBILITY OF DIFFERENT VARIETIES.

So far as we know at the present time there are no varieties that are entirely immune to the disease. Several have been reported by growers as showing a greater power of resistance than others, among which may be mentioned the Duchess, Kiefer, Seckel, Anjou and Anjouleme. The more susceptible varieties are the Flemish Beauty, Clapp's Favorite and Bartlett.

Among the apples, the crabs in every case seem to take the disease most readily, but even here there are some which are freer from blight than others. It has been observed that the same variety in different localities and under different climatic conditions will exhibit different degrees of resistance. The Colorado Experiment Station* cites one case in a certain locality where Martha and Whitney crabs were grown alternately. The Whitney trees were either all dead or dying while not one of the Marthas was affected. However, in other localities the Marthas had succumbed to the blight.

In selecting trees, be guarded by local experience and choose the varieties which have done best in your locality.

*Bulletin 41 Colorado Experiment Station.

## BACTERIOSIS OF BEANS.

Frequently the foliage, stems and pods of the common beans as well as the Lima bean are preyed upon by a bacterial disease* known as Bacteriosis. The symptoms are such as to make it readily distinguishable from all other maladies to which the bean is heir.

There appear on the different parts of the plant, especially on the leaves, large, watery, brown patches or blisters that soon dry up and cause the tissue to become brittle and to curl leaving the foliage ragged

FIG. 3.—Bean Leaflet, showing Bacteriosis. (Halsted. New Jersey Station Bulletin No. 151.)

and good for nothing. The pods seem to furnish the best food supply for the microbes and it is here that we find the disease at its best. Small discolored spots appear at first which spread very rapidly and produce large lesions with pink or reddish brown borders and having pale yellow or amber colored crusts over the affected areas. This crust is due to the accumulation of myriads of amber colored bacteria which have formed a layer over the broken down tissue. After a time the pod rots and the beans are worthless.

Warm, wet weather seems to favor the disease for the germs grow best under these conditions and the beans at the same time produce more succulent growths which are more readily attacked. Rain and dew are doubtless agents in spreading the germs from one part of the

* Pseudomonas phaseoli (Smith).

plant to another by washing them from old lesions onto unaffected parts. Insects play an important part in disseminating the trouble, consequently any measures which tend to check these pests will aid in controlling bacteriosis. The distribution of the disease is further effected by dead vines and leaves carried on the wind; by the soil and through the seed. New land which has never grown beans seems to be freer from the disease than old and should always be used when available.

The seed used in planting should be selected by hand and all the lighter ones discarded, for Gain* reports that anthracnosed seeds are less dense than sound ones. As yet no satisfactory method has been found which can be recommended for treating the seed to destroy the casual microbe which does not lower the viability of the seed.

Inasmuch as the germs of bacteriosis work on the outside of the plant,

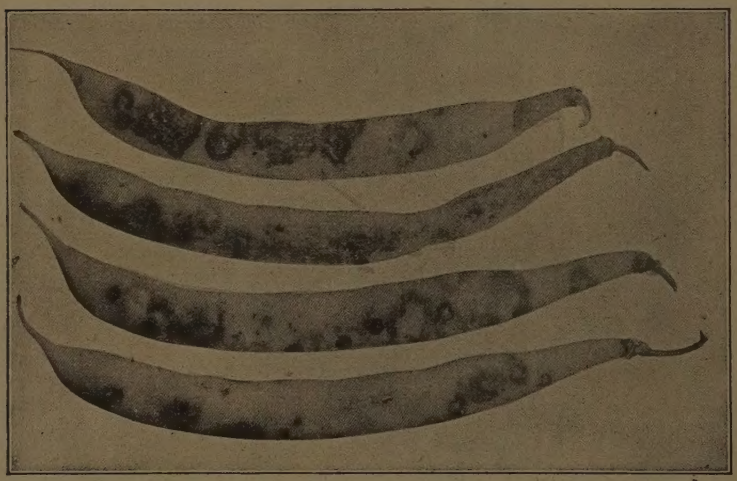

FIG. 4.—Four Bean Pods with Bacteriosis. (Halsted. New Jersey Station Bulletin No. 151.)

it is possible to reach them with a fungicide and spraying with Bordeaux mixture* upon two and three inch plants followed by the same ten days later and again after blossoming.† Dr. Halstead uses a Bordeau mixture of the following strength: Copper sulphate, 6 lbs.; lime, 4 lbs.; water, 60 gals.

Variety tests conducted by the New Jersey Experiment Station during the three years 1897-1899 with Green Flageolet, Currie's Rust-proof, Early Mohawk, Golden Wax, Extra Early Refugee and Saddleback Wax showed the Green Flageolet, the most susceptible, and the Early Refugee the least.

* Bulletin 151 N. J. Exp. Sta.
† Bulletin 121 Ohio Exp. Sta.

## BLACK ROT OF CABBAGE.

The black rot of cabbage is to the truck producer what pear blight is to the fruit grower; in fact, it may be considered far worse, for on the one hand there is only the loss of the crop while on the other not only is the cabbage destroyed but in addition the soil on which it has been grown is so inoculated that it is practically useless to attempt to raise the same crop on the same field with any degree of success for a number of years.

Bacterial examination of diseased plants has shown the sickness to be due to a kind of germ.* The disease is by no means confined to the cabbage but attacks other cruciferous plants such as cauliflower, collards, kohl rabbi, kale, brussels sprouts and broccoli. It has also been

FIG. 5.—Cabbages showing effect of artificial inoculation. Middle plant vigorous and healthy (uninoculated). Plants 1 and 3 inoculated with Black Rot germs. Note dwarfed, one sided manner of growth. Russell. (Wisconsin Station Bulletin No. 65.)

reported as occurring in turnips, rutabagas, wild radish and mustard. It is widely distributed in the United States, having been found most prevalent east of the Mississippi River. In 1891 Prof. W. Paddock reported it from Colorado. Previous to 1899 we do not hear of the black rot in Europe but the investigations of Harding,† confirmed by foreign workers, show the disease to be wide spread and of long standing. England, Holland, Denmark, Austria and Switzerland are mentioned as constant sufferers from the malady. This is peculiarly interesting, since a few years back a great deal of our cabbage seed was imported from Holland and Denmark. The comparatively recent discovery of the infection in Europe is probably due to the better methods of diagnosing the disease than formerly rather than to recent appearance of the trouble. Cabbage growers of Europe have observed it for many years, it seems, but they were accustomed to associate the cabbage worm with the rot rather than the true bacterial cause.

* Pseudomonas campestris (Pannuel) Smith.
† Cent F. Bakt. II. Ab. Bd. VI.—305-313. (1900).

The disease can be recognized by the dwarfed, one-sided growth of the plants and in some cases, failure to produce heads. Sometimes the head will rot and fall off but this is not a necessary accompaniment of the disease for this symptom together with the bad smelling head may be due to the work of other bacteria which are living on the tissue already weakened by the true black rot organism. In the early stage of the

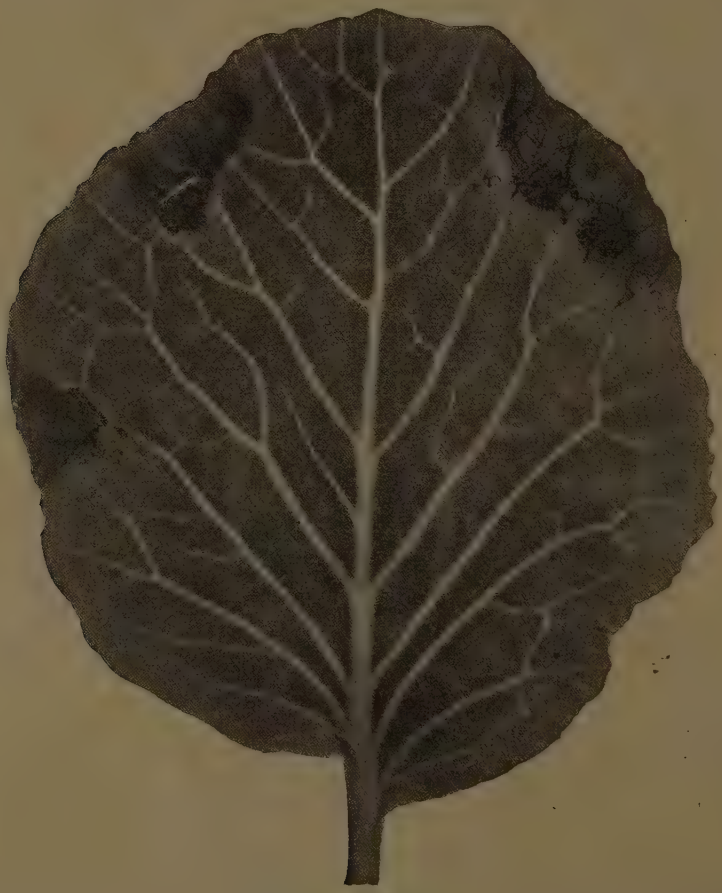

FIG. 6.—Cabbage Leaf affected with Black Rot, Water Pore infection. (Stewart and Harding. New York Station Bulletin No. 232.)

disease, the leaves show a withered, dried appearance along the margin followed by a yellowing in time. The small ribs that lead to the mid rib are usually blackened first and ultimately the larger ones and the mid rib succumb. On cutting across the stem of an infected leaf or sick stalk, one can see the blackened ends of the fibrous strands, known as the fibro vascular bundles, which lead from the stalk out into the

leaf and supply it with water and soil foods. A microscopic examination of these vascular bundles will show the tiny tubes of which they are composed to be alive with germs. As soon as these food and water channels are destroyed, the blade of the leaf is no longer able to get the subsistance required and dies. Diseased leaves usually fall prematurely, leaving a long naked stalk with a tuft of leaves at the tip. The old leaf scars will show the ends of blackened strands corresponding to the diseased fibro vascular bundles in the leaf.

It has been found* that the most common method of infection in the field is through the very small water pores scattered over the blunt teeth on the margin of the leaf. It is by these water pores that a part of the soil moisture that is taken up by the root system escapes from the plant as water vapor but if the surrounding atmosphere is very moist, there will be no evaporation and the water will be seen to accumulate in tiny droplets just over the pores. However, if the soil is very dry, even though the air is moist, we do not have these water beads formed. They can be seen frequently in the early morning on the surface of the leaves and are frequently mistaken for dew. It must be borne in mind that the air is always filled with dust and numerous bacteria and among these there are almost certain to be the germs of black rot, especially if the wind is blowing over a sick field carrying with it fragments of rotting plants and infected soil. These germs are in the beads of moisture, referred to above, and finding a comfortable lodging place and abundant food and water supply, they multiply very rapidly and being able to move about, soon find their way down through the water pores into the veins of the plant. Here they continue to multiply and work toward the stalk leaving behind them the blackened veins and withered blades. The germs may also gain entrance by means of the bites of gnawing insects and again by way of the broken roots at the time of transplanting.

There is no question but that in many cases the plants are taken from the seed bed in a diseased condition and when transplanted into the field spread the germs through the soil rendering it unfit for cabbage growing in the future. When the source of the infection is confined to such a limited space as the seed bed, it is possible to sterilize the soil to a depth of five or six inches by covering it with brush and cord wood and burning it, the heat produced penetrating sufficiently deep to kill most of the surface bacteria as well as troublesome weed seeds. This is a very common practice with tobacco growers and has met with great success wherever employed. If this is not practicable, the seed bed should be located in a new place each year and where cabbage has never been grown. It is only reasonable to suppose if your plants are in a good vigorous condition when transplanted into a "healthful" field, their chance of living is vastly greater than if sick from the start.

When stable manure is used for fertilizer, every precaution should be taken to keep infected cabbage refuse from getting into the manure for in this way the whole heap will become infected with the rot germs and when it is spread on the field the entire plat will become inoculated. One of the worst plant disease epidemics on record was caused in this very way. The writer refers to the present watermelon wilt in North Carolina, South Carolina and Georgia, where melon growing for the

* Bulletin 65 Wis. Exp. Sta. Farmer's Bulletin 63, U. S. Dep't. Agr.

past two years has been practically abandoned by the smaller producers because of the ravages of the wilt. The only safe way to dispose of refuse is to burn it.

It has been demonstrated experimentally by Harding,* Stewart and Prucha that the cabbage seed itself is contaminated with the black rot germs, that some of them could live over winter on the seed and become the source of infection to the young cabbage plants. They advise disinfecting the seed before sowing by soaking it in a 1-1000 solution of corrosive sublimate† for fifteen minutes or in formalin, one pound in thirty gallons.

The removal of sick leaves in the early stages of the disease is practiced by some growers with success. Others have tried this preventative and found it to be a complete failure. The recent investigations of Stewart‡ and Harding condemn this practice and prove quite conclusively that the method is not only harmful to the plants but also worthless. The treatment fails, they say, because

> "The removal of so many leaves checks the growth of the plants; infection occurs by way of the roots as well as through the leaves; infection may occur at the base of the leaf close to the stem and get into the stem unobserved; the germs of the disease are so widely and so abundantly distributed that it is useless to try to stamp out the disease by the removal of diseased material."

Warm days, cool nights and frequent showers seem to accelerate the rot. Smith§ is inclined to think that cabbage planted late is less susceptible than that which is planted early. In selecting cabbages for producing seed the following season, care should be taken to pick out only those which are absolutely free from the infection.

When cabbage is to be stored over winter, the heads should be examined critically and any diseased ones rejected or kept by themselves. The room or store house must be kept cool, below 40° F., and must have uniform ventilation.

It is a matter of common observation that when cabbage is grown year after year on the same piece of land, there is a notable increase in the amount of rot. In the first place, such a method is not to be recommended from an agricultural standpoint since it violates the important principle of crop rotation and further, if it becomes necessary, because of limited space, to continue using this land, our only hope of getting rid of the disease is to grow crops other than members of the cabbage family for five or ten years and longer. During this interim the land must be kept free from all cruciferous weeds which harbor the bacteria, especially from the common wild mustard.

If possible, cabbage should be set each year on ground which has not been planted to it for some time or which has been in sod several seasons or else cultivated to crops which are not affected by the rot. The one important thing for the gardener to observe if he would be a successful cabbage grower, is to take the utmost care to keep his field from becoming infected, and if once infected not to spread the malady over his whole farm.

* Bulletin 251, N. Y. Exp. Sta.
† Corrosive sublimate, 1 part; hydrochloric acid, 2 parts; water 1000 pts.
‡ Bulletin 232, N. Y. Exp. Sta. (1903).
§ Loc. Cit. pp. 12.

## WILT OF THE CUCUMBER, MUSKMELON AND SQUASH.

This disease of the Cucurbits does the most damage early in the season when the vines are just beginning to run. Sometimes, however, seedlings succumb to the infection while again the wilt does not appear until the vine is in full bearing. Such an instance was observed in the cucumber forcing house at the college this spring. The vine was apparently healthy and doing well when suddenly the leaves began to wilt as if from lack of water or too much hot sun. There was no drying or shriveling of the leaves and in two days the plant was dead. A microscopic examination of a cross section of the vine and larger roots showed the vascular bundles to be plugged with bacteria. No fungi were found and there was no indication of insect work on the roots.

The writer has observed the same wilt on the muskmelon. The symptoms here are the same as for the cucumber as are also the symptoms for the squash; sudden wilting as from lack of water caused by the clogging of the watertubes, followed by prostration and death. Usually one runner will die at a time, beginning at the tip and working back toward the root. Growers seem to think the wilt is worse during wet weather and just after a heavy rain, especially if the sun comes out very hot. Spraying is useless and preventative measures suggest pulling up the sick vines and burning them. The suggestions given for the prevention of potato blight will apply here also. Plant on new land as far as possible and avoid the use of fields which have shown the infection. Rotation of crops is also advised.

Smith* ascribes the wilt to a bacillus† which he believes is carried from diseased to healthy plants by the cucumber beetle and squash bug, hence the necessity of destroying these insects.

## SOFT ROT OF THE SUGAR BEET.

This disease was first described and the specific germ‡ isolated by Metcalf and Hedgcock§ in 1902. Beets affected with the rot show the lower half badly decayed and the rotten part honeycombed with "pockets" or cavities filled with a slimy, stringy fluid, colorless and sour smelling. The vascular bundles remain intact while the tissue surrounding them is usually consumed. The normal color of the beets differs so that it is difficult to give any hard and fast color characteristic, but when affected the tissue first shows a yellow, changing to a clay color or gray; later these colors gradually darken. In some cases beets that are badly rotted show no discoloration while others in the early stages are very dark. Above ground the beets appear normal.

* Proc. Am. Asso. Ad. Sci. 1895, pp. 190.
† Bacillus tracheiphilus (Smith).
‡ Bacillus teutlium (Metcalf).
§ Seventh Annual Report, Neb. Exp. Sta. (1904).

A microscopic examination of viscid liquid that fills the cavities of the rotting tissue shows millions of bacteria, which when grown later in pure culture and inoculated into healthy beets produced symptoms typical of the disease.

The germs gain entrance into the beet through wounds and abrasions in the skin and there is good reason for believing that nematodes are responsible for many of the inoculations. So far as experimental work goes, there is no evidence that infection can take place except through cuts or scratches in the outer surface of the root. In the field, the disease has been observed to progress most rapidly under warm and wet conditions; more mature beets are affected more severely than the younger ones, probably due to the larger amount of sugar present.

If the beets are stored in silos and rotting sets in, they should all be inspected and the decayed ones put in a pile by themselves so that all will not contract the rot. Cold storage does not seem to have any influence on checking the trouble, for even at low temperatures the germs continue to grow and produce havoc. It is recommended* that beets from sick soil be thoroughly sunned and dried before storing, inasmuch as the desiccation and sunlight have been found to be very detrimental to the growth of the germs.

Prevention is the only remedy that can be suggested at this time. Grow your beets on relatively dry ground, if possible and plant corn or some other suitable crop on your former beet ground where the excess of moisture can do no harm. Our greatest hope of controlling this disease as well as others is by breeding up some resistant variety and by careful selections secure a strain which can be planted on wet land and yet remain immune. There is no question but that such resistant varieties will be forthcoming in the near future now that the scientific world is so wide awake to the wonders of plant breeding.

## BLIGHT OF THE IRISH POTATO, TOMATO AND EGG PLANT.

It has been shown† by Dr. E. F. Smith that a single species of bacteria‡ has the power of producing blight in a number of plants of the potato family. Among the cultivated ones may be mentioned the Irish potato, tomato, egg plant and pepper. Several common weeds such as the horse nettle, jimson weed and ground cherry are also susceptible to the disease. However we are especially concerned with the disease as it occurs in our common garden vegetables.

The blight manifests itself in the vines by a sudden wilting either of a part or the whole. The stems usually wither, turn yellow and finally black. Young plants appear to contract the disease more readily than old ones. By cutting across the affected stem one can see the characteristic brown or black woody tissue in which the bacteria are at work

* Cent. f. Bakt. II Ab. Bd. VII.—1 & 2.
† Bulletin 12 Div. Veg. Path. U. S. Dept. of Agr.
‡ Bacillus solanacearum (Smith).

The tubers from sick plants show a distinct ring of discolored tissue a short distance from the outside of the potato.

Fungicides are of no value in treating the disease and prevention is the only remedy. Do not use diseased tubers for planting and avoid planting on potato sick land as well as on land which has had diseased tomatoes or egg plants.

The symptoms of the blight in the tomato and egg plant are much the same as those for the potato. The vines wilt as if suffering from too hot sun or lack of water. Decay of the stems and branches soon sets in, resulting in the destruction of the plant.

Here, too, spraying has been found useless for the cause of the disease is deep seated within the tissue and beyond the reach of any germicide. Insects, undoubtedly, play some part in carrying the germs from plant to plant and thus spread the trouble, but the soil seems to be the principal medium of infection. What has been said in connection with the potato may be said about planting tomatoes and egg plants on land that has had diseased specimens of the potato family.

If the disease is not too general, it is possible to control its spread by removing the dead vines with the roots from the field and burning them. It is of utmost importance that the vines be destroyed and not thrown down carelessly to start the disease in a healthy part of the field. Remember that you are dealing with a contagious disease and it is your duty to keep it from spreading. One sick vine in your field this year may mean the loss of half your plants next year. Numerous cases have been reported where soil diseases have been carried from farm to farm, up and down the road by the infected mud that adheres to the wagon wheels. The greatest care should be exercised in plowing and cultivating not to drag sick vines over healthy soil for by so doing the disease is spread and what might have been a mild attack is aggravated to such a degree that a general epidemic results. Tools should be thoroughly cleaned before going from an infected field into one free from the disease and as a further precaution, they should be disinfected by washing or dipping them into a 5% solution of either carbolic acid or copper sulphate, commonly known as blue stone. It is important that the gardener's shoes as well as those of his horse be free from clumps of infected soil before going into a new field.

There is a common practice among some farmers of hauling the soil that has washed down a hillside back up onto the shallow places of the farm. If this is done, one should be very certain that the hillside from which this soil has washed is free from all plant diseases, for the writer is familiar with several instances where infection has been spread over healthy land in this way.

Where no remedy can be given, it is clear that our only hope of controlling a disease is by preventing its spread. By observing the foregoing suggestions, it is believed that the most serious plant disturbances can be entirely prevented or at least controlled.

## NOTE.

It is earnestly desired that the farmers and gardeners of the State of Michigan will coöperate with this department in furthering the study of bacterial plant diseases by reporting all diseases of this nature that may come under their notice and also by sending in specimens of suspicious material for examination. Wherever possible the whole plant should be sent, for usually root, stem and leaf are required for a satisfactory diagnosis. Address all of your communications relative to suspected bacterial plant diseases,

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